Developmental Testbed Center: Overview

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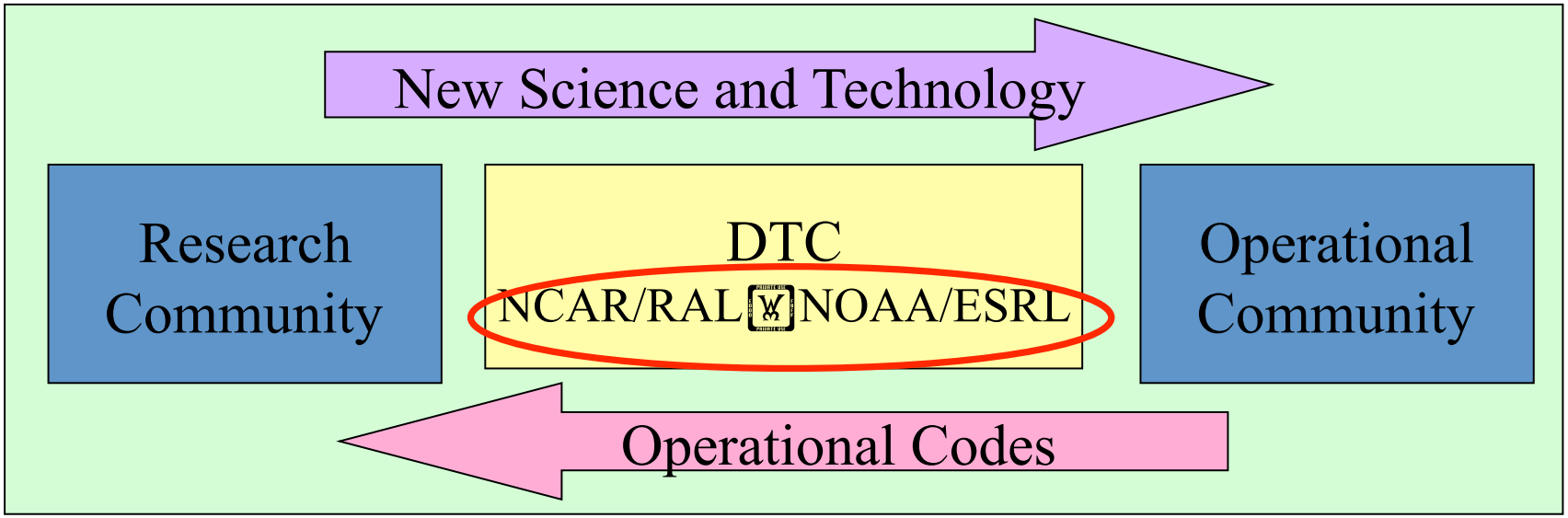
Developmental Testbed Center

1. National Center for Atmospheric Research
2. Earth System Research laboratory
3. National Weather Service

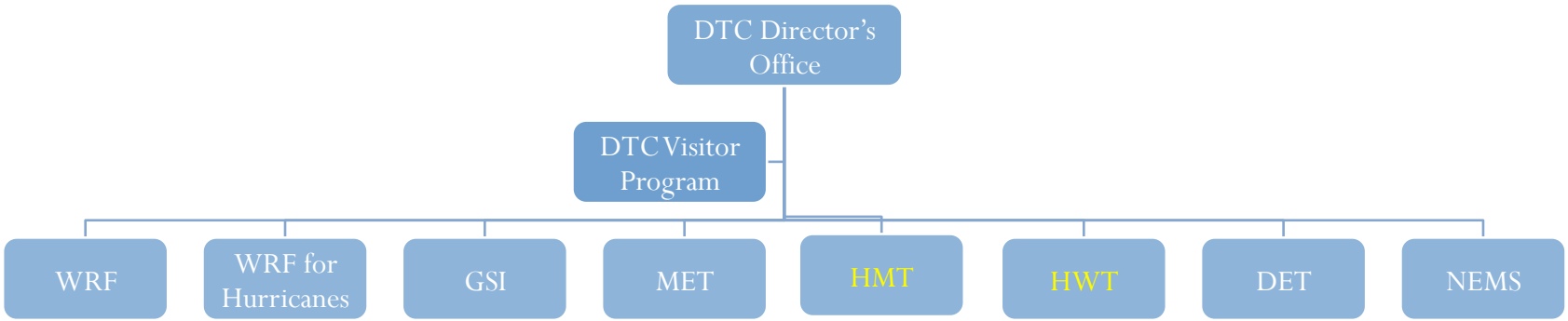
Fundamental Purpose of DTC

To serve as a **bridge** between research and operations to **facilitate** the activities of both halves of the NWP Community

- **Research:** functionally equivalent operational environment to test and evaluate new NWP methods over extended retrospective periods
- **Operational:** benefits from DTCT & E of strengths and weaknesses of new NWP advances prior to consideration for operational implementation



DTC Organization & Tasks



WRF: WRF modeling system
WRF for Hurricanes: HWRF, HFIP
GSI: Grid-point Statistical Interpolation data assimilation system
MET: Model Evaluation Tools
HMT: Hydrometeorology Testbed collaboration
HWT: Hazardous Weather Testbed collaboration
DET: DTC Ensemble Testbed
NEMS: NOAA Environmental Modeling System

Two major functions of DTC:

A. Provide support for community systems
B. Conduct testing and evaluation of community systems for research and operations

Community Code Goals

- A free and shared resource with distributed development and centralized support
- DTC currently supports the following software packages to the community:
  - WRF: NWP model + pre- and post-processors * *
  - Model Evaluation Tools (MET) – Verification package
  - Gridpoint Statistical Interpolation (GSI) Data Assimilation System*
  - WRF for Hurricanes (coupled atmosphere and ocean system) * *
- Provide direct assistance through an email helpdesk for each software package * *
- Facilitate community contributions to the respective code repositories
- Support community outreach events (tutorials/workshops) * *

-in collaboration with MMM* and EMC*

Major Accomplishments for WRF Community Support

- Annual WRF releases* *
  - Bug fix releases as necessary
- Wrfhelp support for WRF-NMM and WPP*
  - ~45 emails per month
- Bi-annual WRF Tutorials* *
  - Typically in January and July
- Annual WRF Users Workshop*
  - Typically in June

-in collaboration with MMM* and EMC*

The Model Evaluation Tools (MET) Community Software for Verification

- Community code for model verification
- Contains both simple and advanced metrics
- Verification advisory group to guide new development
- Supported via email help and web site
- Tutorials twice a year
- Verification methods workshop yearly
- Upcoming enhancements:
  - Ensemble capability (evaluation of probability forecasts)
  - AFWA cloud verification
  - METViewer database and display system

Highlights for FY 2009 Accomplishments

- HWRF V3.2:
  - Bringing the NCEP operational HWRF (based on V2.0) into the general WRF repository
- HRH testing for HFIP
  - Assessing the impact of grid resolution on hurricane prediction
- GSI Repository & code management plan
  - Making NCEP GSI available to the broad community
- Ensemble workshop – Sep 2009
  - Produced a white-paper that will provide valuable guidance to DTC and the NWP community

On-going Activities for FY 2010

- Provide support on community systems:
  - WRF
  - WRF for hurricanes
  - GSI
  - MET
- Conduct T&E activities on these community systems for research and operation.
- Establish a DTC Ensemble Testbed (DET)
- Participate in the development and implementation of NOAA Environmental Modeling System (NEMS) framework
- Conduct community workshops/meetings to facilitate collaboration between research and operation
- Conduct a DTC visitor program

Anticipated Major Accomplishments for FY 2010

- Having a HWRF V3.2 that can effectively serve research and operation:
  - Allow NCEP to configure its operational HWRF from the WRF repository for FY11 implementation
  - Community will be able to conduct research experiments using the same HWRF V3.2 code
  - Work with EMC and HFIP HWRF developers to test and evaluate new capability for NCEP operation
- Develop an effective and functioning GSI Boulder Community Repository to serve research and operation
- Develop a functioning DTC Ensemble Testbed – with input from research and operational communities
- Develop expertise in NEMS and prepare DTC for NEMS community support
- Conduct testing and evaluation of community systems (e.g., WRF, HWRF, GSI, MET) to support research and operations (e.g., HFIP, AFWA, EMC, … etc)

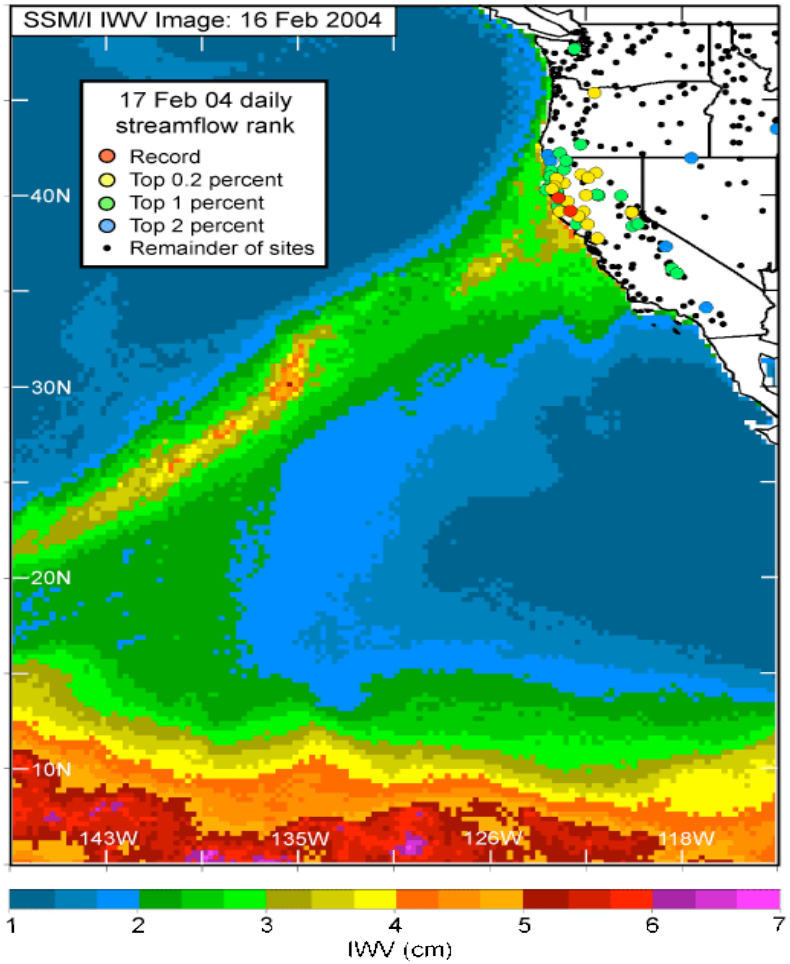
DTC ENSEMBLE TESTBED (DET)*

- Objectives
  - Provide access to operational codes to community
  - Test and evaluate new methods developed by community
  - Support other testbeds / programs with their ensemble work
- Initial focus
  - National meso-scale ensemble system
- Organization
  - NCAR & GSD participation, with EMC/NCEP collaboration
- Status
  - Planning and development of basic capability began
    - Review by WRF Ensemble Working Group at Aug DET Workshop

*A presentation to be given by Zoltan Toth on 5th May at 1:30 p.m.

HMT-DTC Collaboration*:

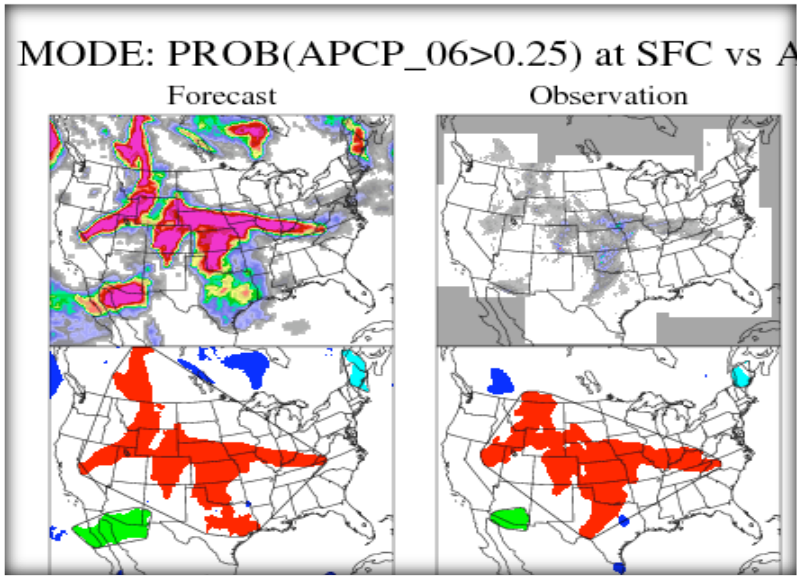
- Goals:
  - Implementation and demonstration of new verification capabilities for high-resolution NWP
  - Data Impact Studies
  - Impact studies of model physics and parameterizations relevant to HMT research
- Accomplishments in FY2009
  - Demonstration of MET-based real-time QPF verification for WRF ensemble forecasts during the 2009-10 HMT West Winter Exercise
  - Retrospective MODE-based analyses of Pacific atmospheric river (AR) observations and forecasts
  - Installations in MET to facilitate regionalized verification at RFC and basin scales



*A presentation to be given by Ed Tollerud on 4th May at 1:45 p.m.

HWT-DTC Collaboration*

- 2009 - Focus on:
  - Impact of radar assimilation on short-term forecasts
    - Manuscript to WAF accepted contingent on minor revisions (Kain et al., in press)
- 2010 - Foci on:
  - Impact of radar assimilation on short-term forecasts of Refl. and Accum. Precip.
  - Probabilistic prediction of Accumulated Precip for heavy rainfall events
  - Forecast of 18dBZ radar echo top heights for aviation purposes



*A presentation to be given by Tara Jensen on 5th May at 1:30 p.m.

DTC support for HFIP*

- Provide HWRF (first NWS operational hurricane model) to the community
- Conduct T&E in support of HFIP activities (e.g., HRH) and other experiments for model development
- Establish pre-implementation testing environment, parallel to EMC, at DTC to help incorporate advances in HWRF into operations
- Establish diagnostic capabilities for detailed model performance evaluation to guide future model development
- Future: DTC will serve as the testbed for incorporating codes (coupling with HYCOM, wave model, and dynamic storm surge model) to support operational hurricane prediction for coastal inundation, waves, and storm surges.
- Longer-term: global hurricane prediction, ensemble hurricane prediction for 7 day forecasts, more accurate genesis forecasts.

*A HWRF presentation to be given by Ligia Bernardet on 4th May at 1:45 p.m.

Lessons learned & best practices

- Good communication is the key to success
  - Internal: Keeping task leads and staff well informed on the on-going efforts and future direction of DTC
  - External: Keeping partners well engaged on DTC's work and plans
- Exchange of staff with partner organization with long-term commitments:
  - DTC staff assigned to work at EMC (e.g., GSI, NEMS)
  - NWS/OST liaison at DTC
- Recognizing the different requirements (and constraints) of research and operational communities
  - Operations: robustness, efficiency, easy maintenance
  - Research: flexibility, multiple-choices, community support

Test and Evaluate NWP Systems

Impacts of Early Test Activities

- WRF Test Plan
  - Demonstrated 6 WRF members tested were qualified to run as an ensemble system
  - 21 Sept 04: IOC - 2 members (ARW & NMM – no physics swapping)
- DWFE (DTC Winter Forecast Experiment)
  - Results helped NCEP decide to upgrade HRW domain 8-km NMM to 5.1 km and 10-km ARW to 5.8 km on 28 Jun 05
  - Demonstrated importance of statistical significance tests when comparing forecast skill from multiple models
- WRF-RR Core Test
  - 1st "clean" WRF dynamic core comparison
  - Selection of ARW for initial implementation of WRF-RR

Transition to Operations: Successes & Challenges

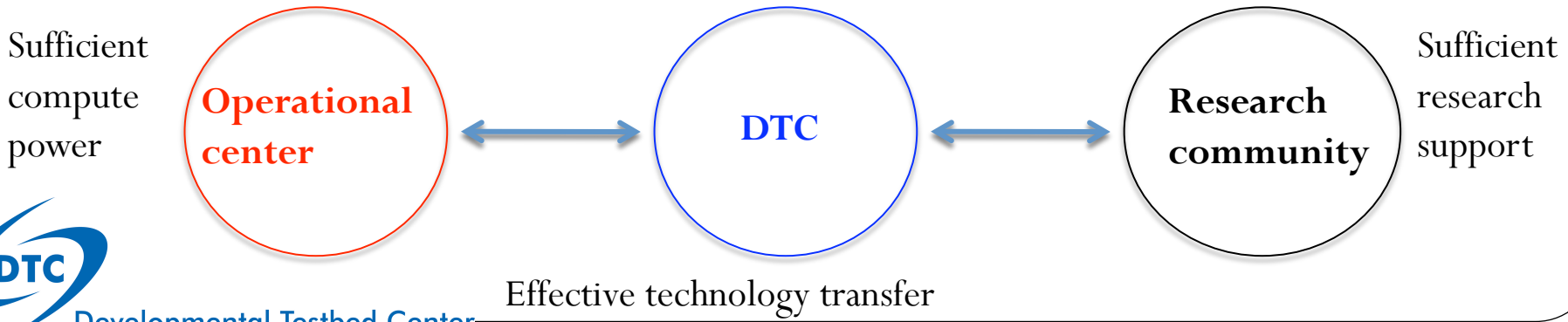
- **Successes:**
  - DTC early test and evaluation contributed to WRF operation at EMC
  - NCEP operational systems are available to the research community via DTC (O2R)
  - DTC and EMC have developed excellent partnership in:
    - Community support (e.g., GSI, hurricane tutorial, WRF workshops)
    - Testing and evaluation (e.g., HWRF V3.2 for operation)
  - DTC's participation in HWT and HMT have been valuable to SPC, WFO, RFC, and HPC
- **Challenges:**
  - Use of community codes for operation is not trivial
  - DTC is NOT an operational center (and should not do EMC's job)
  - Facilitate closer partnership between research and operations (e.g., NCAR and NCEP) on future systems and model framework
  - Execute effective code management plan in collaboration with EMC to facilitate R2O

Future Direction

- **Modeling framework: WRF, NEMS, and ESMF**
  - NCEP is migrating all its systems to NEMS
  - The WRF system remains on its framework
  - How to effectively share modeling system components between research and operation?
- **Global modeling:**
  - Several new global models are being developed with unstructured grids that show great promises
  - These models are expected to run at cloud-/mesoscale resolutions
- **Data assimilation:**
  - The community is moving toward advanced systems: 4D-Var, EnKF, and hybrid
- **Ensemble prediction:**
  - There is a strong need to quantify forecast uncertainties with probabilistic forecasts from cloud to global scales
- **Develop a DTC Strategic Plan**
  - DTC should develop a DTC strategic plan with the help of DTC Science Advisory Board and the broad science community

American Version of ECMWF

- U.S. culture: Competition stimulates advances and innovations in science and technology
- Research and development of NWP is distributed in the U.S., and this is unlikely to change in the foreseeable future
- American version of ECMWF:
  - Close collaboration between research and operation, to allow fast implementation of research advances into operation.
- DTC can facilitate and accelerate transfer of new advances in NWP R&D into operation, through collaboration with operation and the research community



THANK YOU!

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